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A New Polycotyloid Plesiosaur

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ABSTRACT: A new specimen of plesiosaur from the Greenhorn Limestone formation of Kansas is described and figured as *Trinocromerum willistoni*: sp. nov. The skull, vertebrae, shoulder and pectoral girdles are described and figured.

A N important specimen of Cretaceous plesiosaur, recorded as No. 5070 in the University of Kansas Museum of Vertebrate Paleontology, has been turned over to this writer for study and description by the Curator, Dr. Claude W. Hibbard. Recognition of this courtesy and of the assistance of Miss Dorothea Franzen, staff artist, in preparing figures of the specimen is hereby acknowledged.

The specimen was found by a road crew in December, 1936, while making a cut on U. S. highway 81 south of Concordia, Kansas. The location is Sec. 16, T. 6 S., R. 3 W.; the horizon is 10 feet below the Jetmore Chalk member in beds which, farther west of this area, have been classified as the Hartland Shale member, Greenhorn Limestone formation, Cretaceous series.

The specimen consists of a skull with mandible, fifty vertebrae, many ribs, most of the pectoral girdle, both pubes lacking some sections, and the ischia almost entire. There are no paddle bones. The specimen is fairly well preserved, but is compressed and distorted in various parts. Owing to the greater elongation of the dental series, the absence of a well-defined inter-clayicular foramen and other lesser characters which will be pointed out in the detailed description, this specimen is designated as a new species. In recognition of the important work on the plesiosaurs of Kansas and elsewhere by the late Professor S. W. Williston, the name of *Trinacromerum willistoni* sp. nov. is proposed.

Trinacromerum willistoni sp. nov.

Type. University of Kansas Museum of Vertebrate Paleontology No. 5070. Skull with mandible, fifty vertebrae, many ribs and most of the pectoral girdle.

Type locality. Sec. 16, T. 6 S., R. 3 W., in a cut on U. S. highway 81 south of Concordia, Kansas.

Horizon. Ten feet below the Jetmore Chalk member in beds which, farther west of this area, have been classified as the Hartland Shale member, Greenhorn Limestone formation, Cretaceous series.

Diagnosis: Related to *Trinacromerum osborni*, but differing in having the premaxillaries extending farther back; in having a larger maxillary tooth series (at least 34 as compared to a possible 26), interclavicle relatively much larger, and lacking the large foramen.

Description of the type. The skull is long and tapering with narrow face and short cranium, similar to that of the well-known holotype of *Trinacromerum osborni* Williston (K. U. M. V. P. No. 1300). The specimen under study has the appearance of a fully mature individual, while the holotype of *T. osborni* shows a number of juvenile characters. The skulls of both specimens are laterally compressed. That of *T. osborni*, being preserved in the chalk, has a better surface texture and the sutures are quite readily recognized, while the former has suffered many minute fractures. These fractures, together with the more complete ossification, due to advanced age of the individual, make it difficult to trace some of the sutures. (See Fig. 1.)

The *premaxillaries* are long and narrow, extending backward to a point beyond the center of the orbit. The median articulation is well marked through the greater part of its length, but in a space of 100 millimeters anterior to the orbit it is lost in the relatively smooth and well-rounded surface. The articulation with the maxillaries and the nasal bones is less distinct, but traceable forward to a point

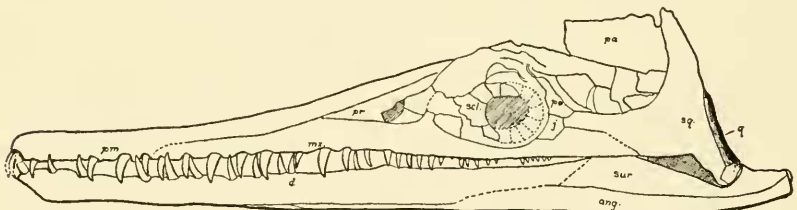


FIG. 1. Skull of *Trinacromerum willistoni* sp. nov., No. 5070, left side view. pm, premaxillary; mx, maxillary; pr, prefrontal; pa, parietal; po, postorbital; sq, squamosal; q, quadrate; d, dentary; ang, angular; sur, surangular.

above the seventh tooth, where it is lost. The posterior extremity of this bone is laterally compressed and terminates in a wedgelike form, enclosed between two laminae of the frontal bones. It differs from that of *T. osborni*, as described by Williston, in extending farther backward and in the evident characters of a more mature individual.

The *maxillaries* extend beyond the middle of the temporal arch. They are characterized by the very elongated dental series, including no less than thirty-four teeth as compared with a possible twenty-six in *T. osborni*. The teeth are uniformly large to a point about the middle of the series, then steadily decrease in size and in the interval separating them. The series terminates at a point below the posterior margin of the orbit, leaving an edentulous border of 70 millimeters. The greatest breadth of the maxillary is near the middle of the dental series; below the orbit it narrows to a diameter of 13 mm.

The *frontals* are not distinctly marked in their outlines. They apparently enclose and overlap the posterior extremity of the premaxillaries. There are, above the orbits, a pair of relatively prominent and rugose superciliary crests whose homologies are doubtful. In this specimen these crests are compressed, so that the superior wall of the orbit appears on the lateral surface. Neither the anterior nor the posterior articulations of the frontals has been determined.

The *parietal bones*, though laterally compressed in this specimen, were doubtless quite narrow. They present a thin vertical crest, extending backward from a point above the orbit. Whether or not they meet the premaxillaries remains in doubt.

The area, anterior to the orbit which should include the *lachrymals* and the prefrontals is too badly fractured to admit of accurate description. The anterior part of the prefrontal is seen at the angle between the maxillary and the premaxillary.

The *squamosal*, as figured in many plesiosaurs, is a broad, branching bone with its posterior margin articulating with the quadrate and sending a superior branch upward so as to overlap the parietal and apparently meet its fellow in a crest. The anterior branch, more broad and flattened than the other, forms the greater portion of the temporal arch. There is no evidence of a quadratojugal element in this specimen and in deference to Williston's later conclusion that this bone does not occur in plesiosaurs,¹ no indication of its presence has been made on the accompanying drawing. How-

1. (*Trinocromerum*. Jour. of Geol. Vol. 16, 1908, p. 715.) (*Osteology of the Reptiles*, Harvard Univ. Press, 1925, p. 56.)

ever, it is observed that S. P. Welles² in a recent monograph on "Elasmosaurid Plesiosaurs," definitely described and figured it as present in *Hydrotherosaurus* and *Thalassomedon*.

The *quadrate* is a strong bone joining the squamosal posteriorly at a right angle and presenting its broad surface on the posterior aspect of the skull.

The *angular* extends forward beyond the middle of the dentary where it overlaps a small portion of the splenial as exposed in the lateral view.

The *mandible* is long, straight on its inferior border and tapering in breadth from the coronoid eminence to its anterior extremity. It articulates with the quadrate in an elongated glenoid fossa; the posterior member is strongly recurved and truncate at the extremity. The dentary bone is plainly marked, extending posteriorly to a point some 40 mm. from the end of the opposing maxillary. The dentition can be traced no farther than to a point below the center of the orbit, probably because of the imperfect preservation of the specimen. The surangular, is somewhat broader than the angular. The articular apparently does not project beyond the glenoid fossa so as to be seen on the lateral surface.

Measurements	mm.
<i>Skull</i> , alveolar border to occipital condyle.....	640
<i>Skull</i> , alveolar border to quadrate.....	692
<i>Skull</i> , length of maxillary.....	594
<i>Skull</i> , length of upper dental series.....	513
<i>Skull</i> , greatest breadth of maxillary.....	32
<i>Skull</i> , least breadth of maxillary.....	13
<i>Mandible</i> , greatest length.....	745
<i>Mandible</i> projection, posterior to articular surface.....	55
<i>Mandible</i> , depth at coronoid eminence.....	65

Some fifty vertebrae are included in this specimen, many of them entire though more or less laterally compressed. Of this number, fifteen are cervicals, including the atlanto-axis complex and the four succeeding cervicals in series.

The *atlas* and *axis* are combined to form one piece and, due to the mature age of this individual, are more or less coössified. Some of the sutures described by Williston in the holotype of *T. osborni* do not appear in this specimen. (See Fig. 2.)

The atlas consists of five parts: Two paired neurapophyses, two subtriangular odontoids and a single massive intercentrum. The neurapophysis of the right side is preserved, the left being separated from it at the median line and lost. This is a relatively broad, flat

2. (Memoirs Univ. of Calif., Vol. 13, No. 3, 1943, pp. 133-157.)

bone which presents a small concave, anterior surface to the occipital condyle of the skull and joins by suture with the odontoid which has not been recovered in this specimen. Posteriorly, it joins the atlantar neurapophysis in a vertical suture. Superiorly it terminates in a short and laterally flattened, spinelike process; at the inferior extremity it joins the intercentrum. The axial intercentrum is a strong bone, having a hemispherically concave facet at its antero-superior surface. It occupies a median position and supports the occipital condyle from below. The inferior surface bears a slight median keel which extends along the posterior half of its length. It articulates posteriorly by suture with the axial intercentrum.

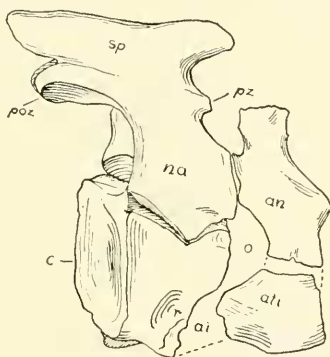


FIG. 2. Atlanto-axial complex. na, axial neurapophysis; c, centrum; ai, axial intercentrum; r, axial rib; pz, prezygapophysis; poz, postzygapophysis; an, atlantar neurapophysis; ati, axial intercentrum; sp, neural spine.

The *axis*, in its lateral aspect, approaches the general outlines of a typical cervical vertebra of this animal. It may be distinguished by the elongated neural spine, by the vestigial prezygapophysis and by the much reduced axial rib. The axial intercentra are paired bones, each of which joins an odontoid anteriorly and which extends posteroinferiorly, forming a part of the rib attachment and meeting the axial centrum in a curved suture. The axial rib, which is firmly coösfied on the left side, is mostly broken away from the right. It is rounded, tapering and fanglike in form. The centrum is the larger and more massive part of this vertebra. Posteriorly, it presents a typical vertebral articulating surface to the succeeding cervical; superiorly it forms two-thirds of the footing of the neural pedicle.

The succeeding cervical vertebrae have moderately amphicoelous centra throughout and gradually increase in size as they approach the dorsal series. The sutures joining the pedicles and the cervical

ribs to the centra are plainly marked. The centra are apparently higher than wide. Their lengths are approximately equal to their height throughout.

Length of cervical centra, 26 mm. to 42 mm.

Greatest length of dorsal centra, 53 mm.

Pectoral girdle. The scapula is preserved on the left side only. (Fig. 3.) It is of the typical triradiate form, common to plesiosaurs. Though distorted by compression, it was evidently quite concave on the mesial surface and marked by a strong, rounded crest which forms the long axis of the bone. It is about one-fifth longer and correspondingly broader than the same in the type specimen of *T. osborni*. The proximal articular end, as seen in the lateral view,

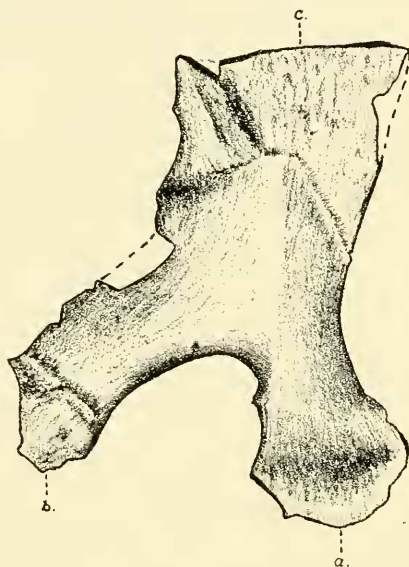


FIG. 3. Scapula, lateral view. a, brachial articulation; b, mesial branch; c, axial border.

is uniformly rounded, in decided contrast with the two distinct facets observed in the smaller species. The mesial border is less strongly concave; the distal end is broad and presents a slightly curved extremity for cartilaginous attachment. The lateral ramus terminates in a surface moderately thickened and angular in outline, as seen from the lateral view.

The *clavicles* (Figs. 4, 5,) are both preserved, the right one almost in entirety, the left in normal relation with its fellow, but crumpled and broken in the lateral half. All of these parts are flattened from

compression in the matrix so that the natural concave form of the superior surface has been, to a large extent, lost. The two bones are separated anteriorly by a wide interval, filled in by the interclavicals. Posterior to this, the two elements join at the median

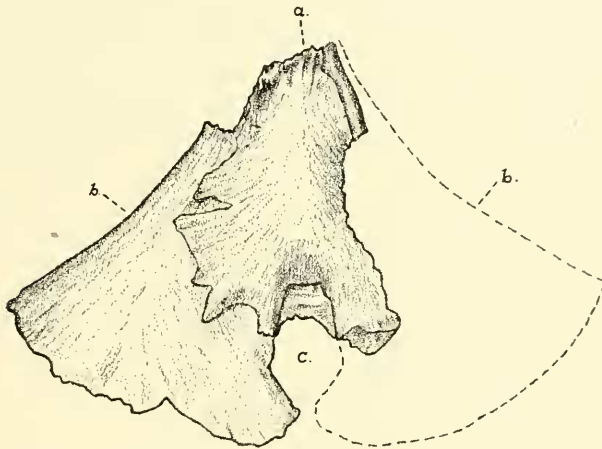


FIG. 4. Clavicles and interclavicle, ventral view. a, interclavicle; bb, clavicles; c, interclavicular vacuity.

line in a serrated suture some 40 millimeters in length. Beyond this, and in the median line, is an irregular vacuity bounded by plates so thin and irregular in outline as to preclude the probability that this was a functional opening, homologous to the large inter-

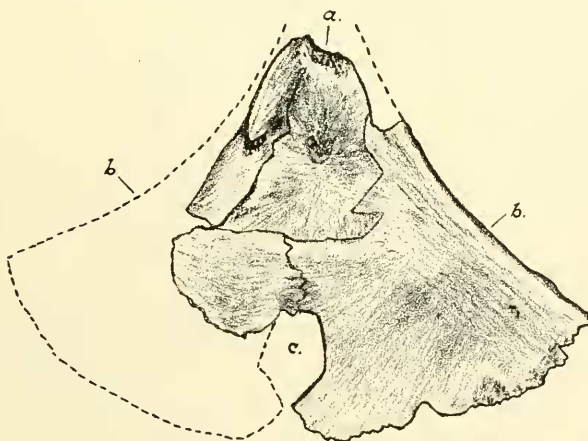


FIG. 5. Clavicles and interclavicle, visceral view. a, interclavicle; bb, clavicles; c, interclavicular vacuity.

clavicular foramen described by Williston in *T. osborni* and erroneously described by Cragin (1888) as the pincal foramen of the cranium.

Each of the *clavicles* sends forward a narrow platelike branch which slightly overlaps the lateral surface of the interclavicle and may have joined anteriorly in the median line. Small parts missing from this section make it impossible to say what structure the anterior extremity of clavicles and interclavicles may have had.

The *interclavicle* is a thick and strong plate, concave on the

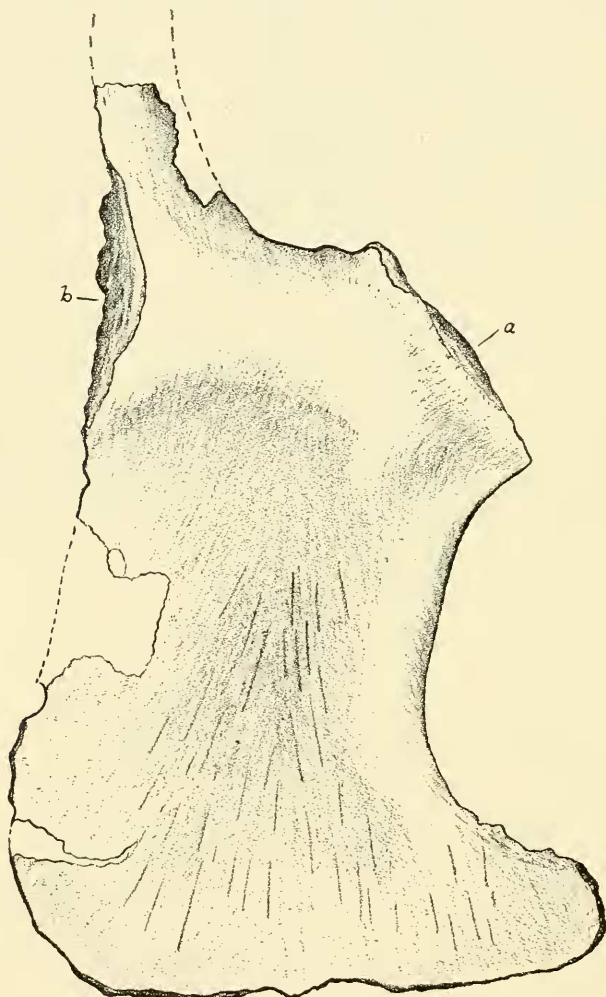


FIG. 6. Right coracoid, visceral view. a, brachial articulation; b, mesial border.

superior surface and rather strongly convex on the inferior. It lacks the prominent ridges which mark the inferior surface of this bone in the smaller species. The lateral margins are deeply serrated where they overlie the clavicles. A median indentation appears at the posterior border similar to that figured in *T. anonymum* Williston. It corresponds with the large interclavicular foramen in *T. osborni* and in *T. bentonianum*³ Cragin. The much greater relative size of this element, together with the absence of the large foramen, clearly distinguish this specimen from *T. osborni* and *T. bentoni-*

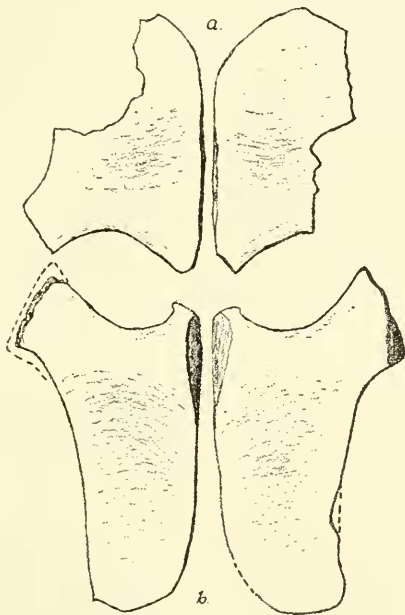


FIG. 7. Pelvic girdle. a, pubes; b, ischia.

anum. The small parts of *T. anonymum*, so far described, leave doubt as to its homologies.

The *coracoids* (Fig. 6) are well preserved in this specimen, the right one almost entire, the left broken into large sections with missing parts. As in *T. osborni*, the coracoids are broad, flat bones which present a lateral shoulder to the glenoid fossa, and are outlined by curved lateral borders and truncated posterior ends, each with a broad, lateral projection, and a straight margin at their median juncture. The glenoid articulation, forming the joint for

3. (N. A. Plesiosaurs, Williston 1903.)

the fore limb, is reinforced by a strong transverse thickening which produces a convexity on the superior surface. A narrow bar, partly broken in this specimen, extends forward from the anteromesial angle to meet the posterior margin of the clavicle. The small foramina appear near the mesial border of each.

Measurements	mm.
<i>Scapula</i> , axial length	254
<i>Scapula</i> , greatest breadth of glenoid ramus.....	90
<i>Scapula</i> , estimated breadth of upper ramus.....	135
<i>Scapula</i> , greatest breadth across glenoid and superior rami.....	222
<i>Interclavicle</i> , length at median line.....	118
<i>Interclavicle</i> , greatest breadth (estimated).....	145
<i>Clavicle</i> , breadth of left, from interclavicular suture.....	165
<i>Coracoid</i> , axial length of incomplete bone.....	470
<i>Coracoid</i> , greatest breadth at glenoid articulation.....	235
<i>Coracoid</i> , greatest breadth at posterior end.....	430

Pelvic girdle. The pelvis, as in most plesiosaurs, is less characteristic than the pectoral girdle. The pubes are more or less broken. They are broad, platelike bones, rounded in the anterior half of the median borders, slightly thickened and convex on the superior surface opposite the femoral articulation. (See Fig. 7, 8.)

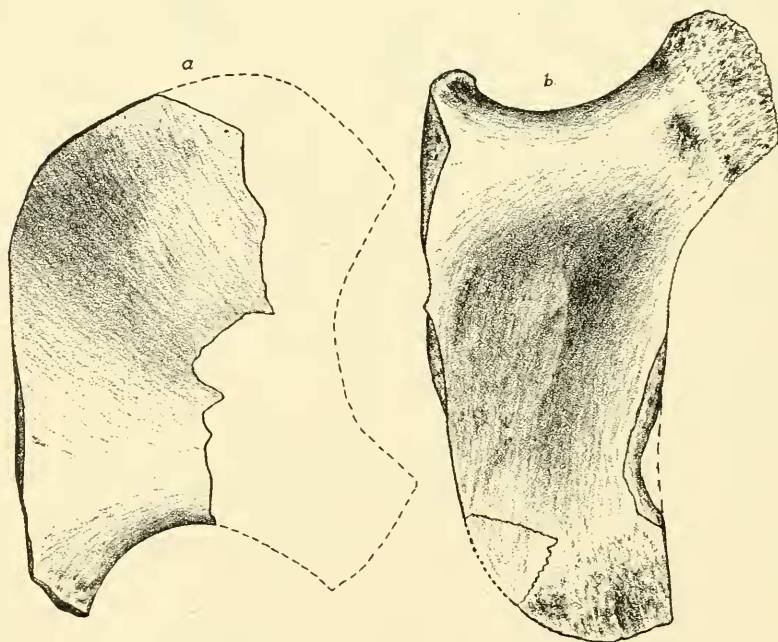


FIG. 8. Pelvic bones. a, right pubis, visceral view; b, right ischium, visceral view.

The *ischia* are almost entire. The anterior ends are convex on the superior surfaces and appreciably thickened to form a transverse bar to support the rear paddles. The greater, bladelike area is concave on the superior surface with the lateral margin considerably elevated.

Measurements	mm.
<i>Pubis</i> , greatest length near median line.....	275
<i>Pubis</i> , breadth of incomplete bone at femoral articulation.....	195
<i>Ischium</i> , greatest length over all.....	360
<i>Ischium</i> , breadth across anterior end.....	205